

CAAP Quarterly Report

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Prepared for: *U.S. DOT Pipeline and Hazardous Materials Safety Administration*

Contract Number: 693JK31850013CAAP

Project Title: A Fast and Low-cost Method to Automate Detecting, Locating, and Mapping Internal Gas Pipeline Corrosion using Pig-mounted Thermal and Stereo Cameras

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For quarterly period ending: 12/31/2018

Business and Activity Section

(a) Contract Activity

- 1) **Contract modification:** No contract modification is expected in this quarter.
- 2) **Material purchased:** Major material purchased in this quarter are the parts for creating the proposed pig device. The detailed items include:
 - a. battery packs to power thermal cameras and stereo cameras, on-board computers, and battery packs to drive the pig moving inside the pipes
 - b. hub-motors and remote controls to control the moving of the pig device
 - c. used inventory computers parts to create high-performance image processing computers

The current total cost for the material cost is approx. \$3,506, which included \$1,222 indirect cost charge by the University of Nebraska-Lincoln.

(b) Status Update of Past Quarter Activities

A kick-off meeting was held on October 1st, 2018 to discuss the scope of work and performance expectations of the project, and how the overall tasks would be split among the participants. The participants of the meeting include the PI, and the two PhD students listed in this project proposal.

In this quarter, the PI focused on the design part of Task 1.1: Design, prototype, and test the pig device with all the mounted devices and cameras. Parts of the designed device were purchased for assembling

in the 2nd quarter. The prototype model was created to be manufactured and assembled in the next stage.

(c) Cost share activity

The PI dedicated 0.4 FTE in this quarter to the project, which is equivalent to $0.4 \times 3 \text{ months} = 1.2$ months of cost share. The portion of cost share in this quarter is \$25,506. The PI is expected to dedicate total 2.91-month research time in the first year, which is amounted to \$61,853.

Task 1.1: Design, prototype, and test the pig device with all the mounted devices and cameras

This task is approx. 50% completion by the end of the quarter. The completed parts of this task are the design of the pig device, and the purchase of some essential parts. There will be more parts to purchase in the next quarter.

Detailed discussion and descriptions for the following:

1. Background and Objectives in the 1st Quarter

1.1 Background

To collect the proposed two-spectrum multi-channel image data, an inline pig-like device (Fig. 1) mounted with both thermal and stereo cameras will be designed and prototyped. The back-end mounted thermal camera will record continuous thermal images. The front-end mounted stereo camera will record RGB and D (depth) surface images. LED lights are also part of the pig device to illuminate the pipe internal surface. A small-form computer will be on-board to operate the thermal camera, stereo camera and IMU sensors, and an onboard odometer. The recorded video clips from the thermal camera and stereo camera will be stored in the computer hard drive. **Battery packs** that supply power to both the thermal camera and the computer will be mounted to the pig. In case of using this device in short un-piggable pipelines extra batteries are needed to move the pig. To increase the location accuracy an optical-flow based speed recorder using the stereo camera videos (Lan et al. 2014) will also be used. Locations of the pig/cameras will be estimated using the three sources of measurements to enhance the corrosion locating performance. All the mounted devices will be connected to the on-board computer.

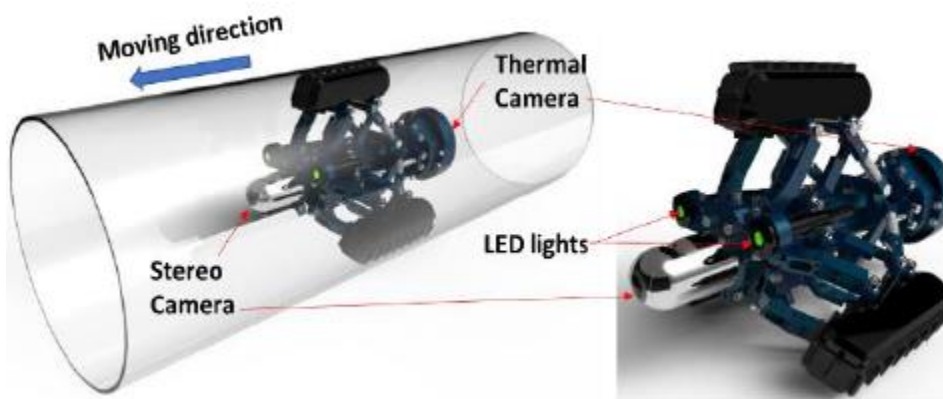


Fig. 1 the pig-like device

The pig-like device to be designed, developed, and prototyped is part of the hardware platform to conduct the proposed experiments in the ensuing tasks. Task 1.1. was planned to take two quarters to complete. The completed prototype will be essential for starting the testing in the s2nd quarter.

1.2 Objectives in the 1st Quarter

Complete the design work of the pig-like device, and start purchasing the necessary parts of the prototype.

2. Experimental Program in the 1st Quarter: N/A

2.1 Experimental design N/A

3. Results and Discussions

The PI completed the prototype design the pig-like device and has purchased the major power-train parts of the device. The PI also reviewed more literature on smart-pig design and applications.

4. Future work

In the 2nd quarter, the prototype pig-like device is expected to be completed for further testing and refining. The hardware platform is expected to be ready.

References

- 1) H.R.Vanaei, A.Eslami, A. Egbewande. (2017). “A review on pipeline corrosion, in-line inspection (ILI), and corrosion growth rate models”. *International Journal of Pressure Vessels and Piping*, 149(), 43-54
- 2) Edet Afangide, Jyoti K. Sinha, K. B. Katnam (2018). “Quantified approach to pipeline health and integrity management”, *Journal of Loss Prevention in the Process Industries*, 54(), 28-36
- 3) Hossam A., KishawyaHossam A.Gabbarb (2010). “Review of pipeline integrity management practices”, *International Journal of Pressure Vessels and Piping*, 87(7), 373-380
- 4) Dino Isa & Rajprasad Rajkumar (2009). “PIPELINE DEFECT PREDICTION USING SUPPORT VECTOR MACHINES”, *Applied Artificial Intelligence*, 23:8, 758-771